ISSUE 3 / 2011

DATA – FACTS – ANALYSIS

CUTEC-News

SOFC: FRENCH PARTNERSHIP

NUCLEAR POWER? NO THANKS! - SO NOW WHAT?

Yellow stickers showing a laughing red sun surrounded by the text "Nuclear power? No thanks" are something that you have probably seen quite often, at least if you are over 40. The logo was created in April 1975 by Anne Lund and Sören Lisberg of Denmark for the country's anti-nuclear movement. It arrived in Germany a year later and was eventually translated into more than 45 languages, becoming a symbol of opposition to nuclear energy. Those of you who are younger quite possibly saw the logo for the first time last year when it made a comeback during marches organised to protest against an extension of the operating licenses for nuclear power stations. Just a few months later in the wake of the nuclear disaster in Fukushima, the German government changed course and made the decision to abandon nuclear power. Based on a timetable agreed with the German states, the power stations will all be shut down by 2022 at the latest. So now what? The transition to renewable energy will have to take place faster than announced by the government only last year. Sun and wind are the prime candidates not only to fill the energy void left behind by the demise of nuclear power but also to generate additional power, making possible the deployment of new technology. An example of that might be the electrolytic production of hydrogen which can then be combined with the greenhouse gas carbon dioxide to make methane (natural gas). Another renewable energy source, which is definitely expected to be part of the future energy mix, is biomass. Competition with food production however will have to be avoided. What makes biomass so important as a renewable energy source is its ability to compensate for natural fluctuations in the generation of solar and wind power. There are, however, problems associated with using it as solid fuel, because the combustion of solids (as opposed to gas) always generates fine particulate emissions. To avoid the problem, I would argue that biomass conversion is the better option. The energy which is contained in a whole variety of biomass residuals and waste can, for example, be transferred to liquid hydrocarbons. This has the advantage that you produce a fuel that has a very high energy density, is suitable for long-term storage and can be transported to the point of use. Despite the current media enthusiasm for wind turbines and parks, various types of biomass will play a major role in the future energy mix. On Page 3, we share some information with you about our own development / trials of a high-temperature heat exchanger which will be used for coupling biomass boilers to Stirling machines. An article on the results of a biological fuel cell study along with a report on a new SOFC project, which we are conducting in conjunction with a French partner, appear on Pages 4 and 6.

So now what? I wish you pleasant reading.

CUTEC AT HANOVER FAIR 2011

CUTEC converts biomass into energy

Mrs. Senkel and Mr. Siemers welcomed Lower Saxony Minister of Science and Culture Prof. Wanka at the CUTEC stand

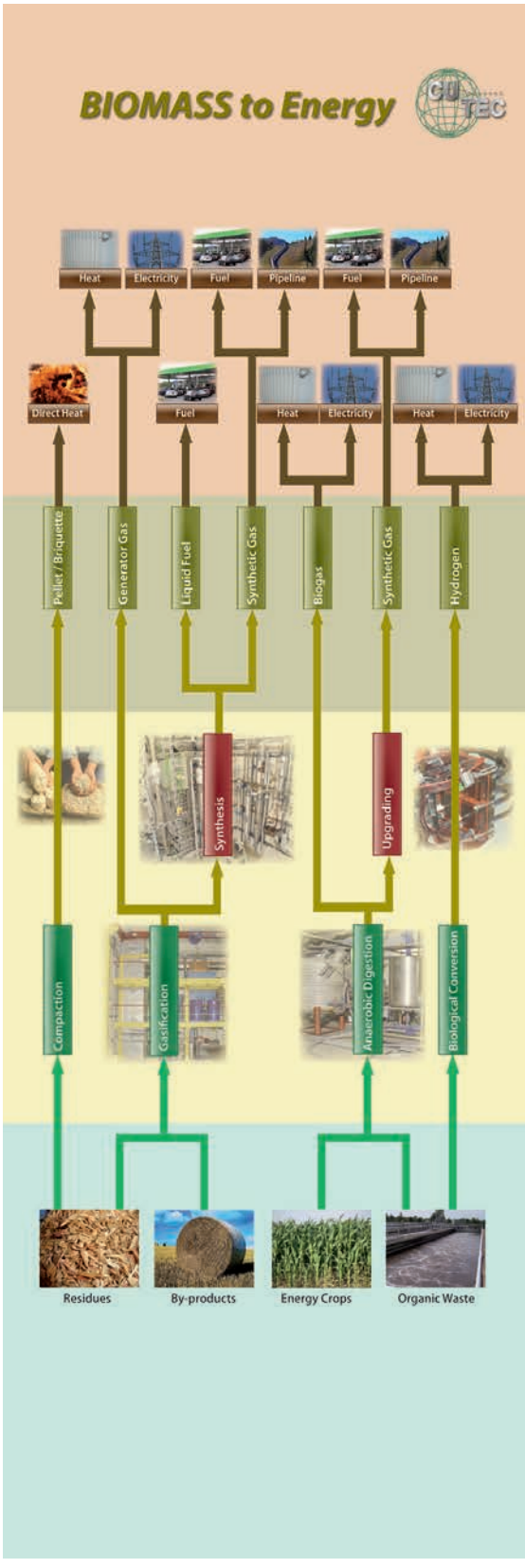
CUTEC was at Hanover Fair 2011 on April 4th - 8th. The event is the world's largest industrial trade show.

Thermochemical and biological biomass conversion was the main theme this year at the joint energy stand in Hall 27. The stand was sponsored by the government of Lower Saxony. This gave CUTEC the opportunity to share information on much of what is currently going on at the Institute. A CUTEC poster (Fig. “Biomass conversion at CUTEC) showing all of the relevant biomass types, the conversion techniques and some of our current research projects provided a very useful basis for discussion. Visitors learned how electricity, heat and fuel can be produced from a broad spectrum of biomass including wood residue, straw and sewage using models, technologies and process flows developed at CUTEC. The list includes gasification, synthesis and biogas production and conversion technologies. CUTEC was virtually the only exhibitor at the show which highlighted the inherent potential of conversion from biogenic residuals.

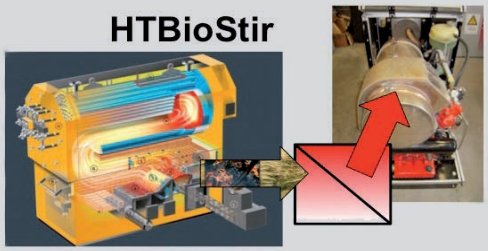
In the wake of the nuclear accident in Fukushima which occurred prior to this year’s Hanover Fair, the level of interest in renewable energy was once again very intense at the show. Besides sharing information with visitors from the non-scientific community, we were involved in many technical discussions as well. We made contact with many of our existing partners, and we also welcomed a number of visitors who showed an interest in CUTEC for the first time. Our presence at the joint Lower Saxony stand also gave us the opportunity to make contact with a number of government officials. We had, for example, a very interesting discussion with Lower Saxony Minister of Science and Culture Prof. Wanka on the issue of biomass vs. food.

A Chinese delegation visited us right at the start of the show, and Mr. Hirche (former Lower Saxony Minister of Economics) also came to the stand unannounced and asked us for a discussion. He was looking for information on new projects which he had no knowledge of. We explained the principle behind the “biological fuel cell”, and he was obviously very impressed. From our perspective, the show was a success again this year. We had a lot of useful discussions and we made some good contacts.

(sk)



Our poster display at this international event, which provided information on biomass conversion at CUTEC



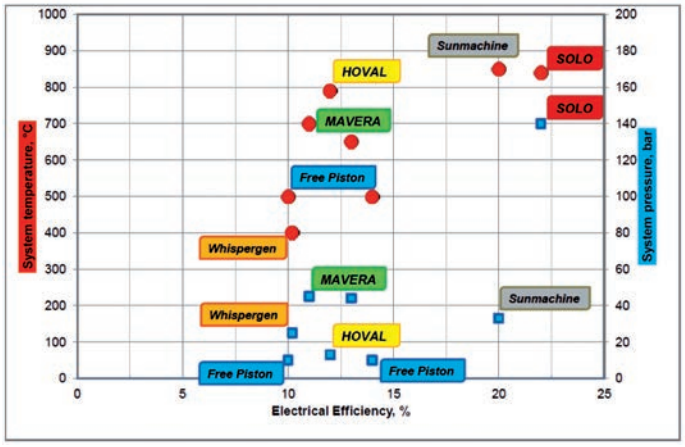
Feature article

DEVELOPMENT OF A HIGH-TEMPERATURE HEAT EXCHANGER

Connecting a wood chip boiler to a Stirling motor

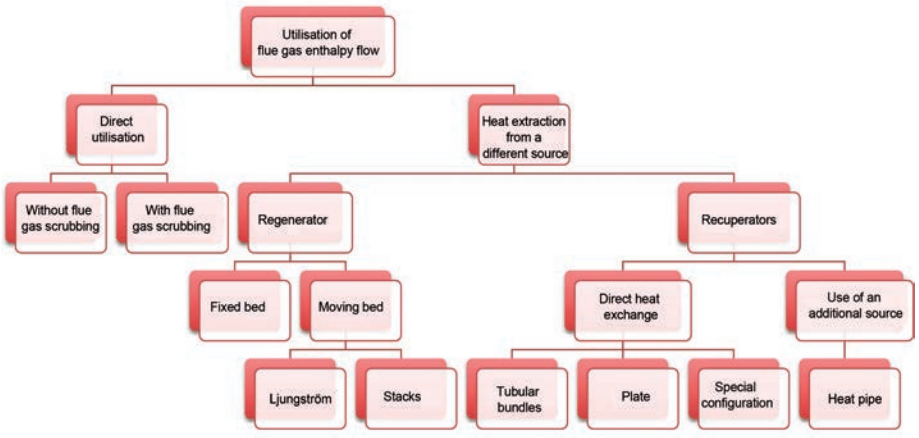
A new energy systems project was officially launched on July 1st, 2011. The existing Stirling motor at the energy park will be connected to the existing wood chip boiler to generate electricity from solid biomass. The project team will be taking a new approach. A heat exchanger will be placed between the boiler and the Stirling motor, so the two will be connected indirectly rather than directly. Heat has to be extracted from the high-temperature zone of the boiler to supply heat at the temperatures needed by the Stirling motor. Placing a heat exchanger between the boiler and the Stirling motor eliminates the contamination and operational problems which would otherwise exist.

In the low power range (< 100 kW or lower down to around 10 kW), it is difficult to generate electricity from solid fuel (e.g. using biomass as a renewable energy source). One solution is to first gasify the biomass. The gas is then used as fuel in a combustion engine which drives an electricity generator. Other technologies provide alternatives to internal combustion engines. Stirling motors, for example, only need an external heat source to operate. Steam engines and new linear generators also do not rely on direct combustion. In the first scenario, a continuous source of upgraded gas must be available. Most low-end gasification technologies are not able to meet this criterion. In the second scenario, new technologies are involved which for a variety of reasons have not been able to establish a foothold. Work over the past 10 - 15 years, which was directed at placing existing Stirling motors (developed for natural gas or CSP applications) in the flue gas flow from biomass boilers, has been hampered by problems associated with contamination, tar deposits, ash melting, etc.

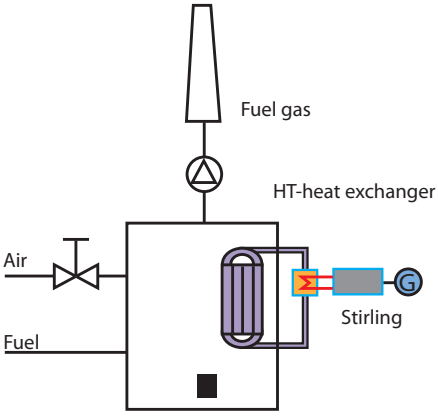


Comparison of different Stirling motors

The new HTBioStir project to develop a high-temperature heat exchanger, which will act as the link between biomass boilers and Stirling machines, represents a totally new approach. To eliminate potential contamination problems at the Stirling engine, heat will be supplied from a heat exchanger (e.g. hot air rather than flue gas directly from a combustion process). At the other end, the heat exchanger has to extract energy from the flue gas flow of a biomass boiler. A number of technical solutions are available for doing that, but the high temperatures needed for this application cause some complications. To achieve acceptable electrical efficiency, the inlet temperatures at the Stirling motor have to be in the region of 800°C. This means that the temperatures at the biomass end need to be something like 1000 – 1,200 °C. Some of the most common heat exchanger systems will not operate at these temperatures. The project team will assess the heat exchange mechanisms (regenerator, recuperator, heat pipe) which are theoretically available and determe what exact conditions need to be maintained for problem-free operation of the boiler-Stirling motor system. Following a pre-selection process, the work needed for implementation and trials with one or two technical solutions will get underway. The necessary up-front work will start this year. Engineering analysis and efficiency assessments will be carried out on the Stirling motor and wood chip systems separately.



Overview of heat exchange technologies



Linking the systems

Jülich will provide financing for the project under the umbrella of the Federal Environment Ministry's programme to optimise the utilisation of biomass as an energy source. A budget of around € 380,000 has been allocated to the 3-year project.

BIOMASS AND RENEWABLE ENERGY IN THAILAND

CUTEC at trade show and workshop

Podium discussion at the UN Food and Agriculture Organisation workshop

During the week of May 30th - June 4th, 2011, biomass and renewable energy were high on the agenda in Bangkok, Thailand. The Renewable Energy Asia (RE Asia) show attracted people from across the region on June 1st - June 4th. Other events were organised to coincide with the show. A Thai-German workshop on biomass energy production was held on May 30th - 31st, and visitors also had the opportunity to attend a number of conferences and seminars. Mr. Siemers from CUTEC was invited to some of these events.

Werner Siemers during his presentation

The Thai-German Workshop on Energetic Biomass Utilization was organised to discuss and promote collaboration between the two countries. The Joint Graduate School of Energy and Environment (JGSEE) provided organisational support for the event from the Thai side. The Energy Engineering and Energy & Conversion Technology (EVUR) Departments at the University of Applied Sciences in Berlin were the partners on the German side. The German Research Foundation (DFG) and its Thai counterpart, the National Research Council of Thailand (NRCT), provided financial support for the technological exchange. Biological conversion techniques, liquid fuels and the environmental aspects of biomass utilisation were the main topics at the one-and-a-half day workshop. The list of contributors at the sessions included Prof. Behrendt from TU Berlin, Prof. Kaltschmitt from TU Hamburg-Harburg and a number of other individuals from German and Thai universities. In his talk, Mr. Siemers gave an overview of fermentation technology in biogas production. The proceedings came to an end with a half-day project development workshop organised by GIZ Thailand (formerly GTZ). Following some lively discussion, the group put together a project proposal to introduce clean high-efficiency multi-fuel boiler systems in Thailand. Thai industry and German manufacturers highlighted problems associated with the shortage of skilled workers and insufficient operational expertise with boiler systems, especially when the fuels involved are more difficult to use. An initial draft is currently under review.

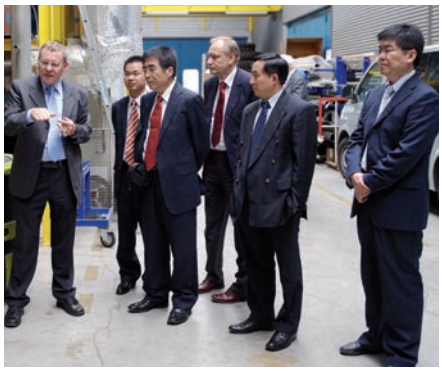
Biogas system at a pig farm in Thailand

Rice paddy in Thailand

RE Asia, which attracted around 17,000 visitors, officially opened its doors on June 1st, 2011. A two-day international conference on Renewable Energy: Energy Security in the 21st Century then got underway. The presentations on the first day focused on the different technologies such as wind, biomass and solar power as well as energy efficiency. The proceedings continued on the second day with the Sustainable Bio-energy Symposium which was organised by FAO (UN Food and Agriculture Organisation). Mr. Siemers was invited to give a presentation and take part in the discussions as a member of the podium at this event. In his

Continued on page 7

CHINESE DELEGATION VISITS TU CLAUSTHAL



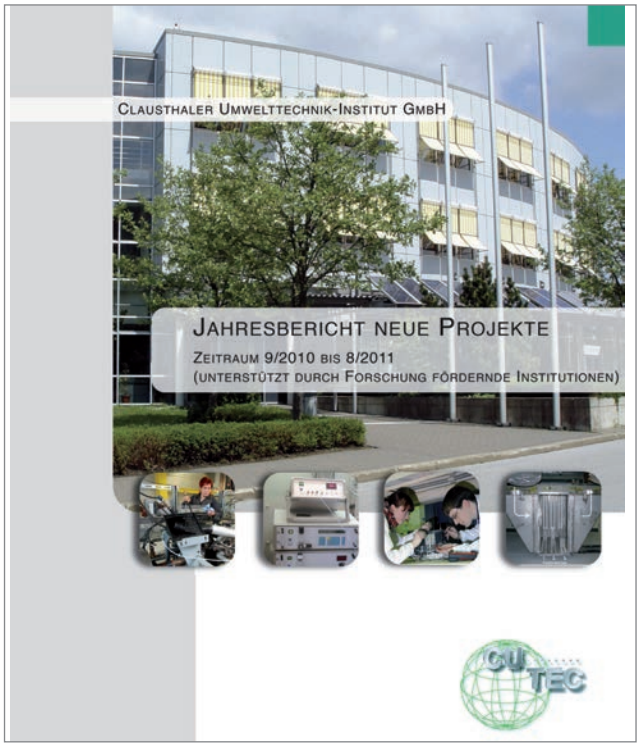
Prof. Carlowitz (left) takes the visitors on a tour of the CUTEC Test Centre

In June, a six-member delegation from Xi'an University of Architecture and Technology led by Professor Delong Xu paid a visit to the TU Clausthal Power Process Engineering & Fuel Technology Institute (IEVB) and CUTEC. The heads of five departments at the university accompanied Professor Xu on the visit. Professors Weber and Scholz, Professor Albrecht Wolter acting on behalf of TU Clausthal, university China Liaison Officer Professor Michael Hou and CUTEC Managing Director Professor Otto Carlowitz were on hand at IEVB to welcome the delegation. Research on energy and energy systems technology and resource recycling at TU Clausthal and CUTEC were the main items of interest during the two-day visit. The itinerary included presentations and a tour of the pilot systems (see photo: Visit to the CUTEC Test Centre). In his presentation, Professor Xu provided information about current research on cement production. (mu/he)

LATEST ON THE APPOINTMENT OF A SUCCESSOR TO PROF. CARLOWITZ

Two days of presentations at CUTEC in June

Seven candidates to succeed Prof. Carlowitz as Managing Director were invited to give presentations in the multimedia lecture theatre at CUTEC on June 23rd and 24th. The candidates had been selected by the Appointment Committee following a review of the applications. The candidates gave a presentation summarising their own scientific work followed by a second presentation where they had the opportunity to outline their ideas and visions on the future strategic direction at CUTEC up through 2020. At the end of the question and answer sessions which followed each presentation, the Appointment Commission under the direction of Prof. Goldmann (TU Clausthal) interviewed the candidates behind closed doors. An external assessment will now be carried out to rank the four candidates who are still in the running. (he)



2011 ANNUAL NEW PROJECT REPORT PUBLISHED

You probably noticed from the weight of the envelope that there must be more inside than the latest issue of CUTEC News. Despite the summer holidays, the new annual report was ready for distribution with the second issue of CUTEC News. We have sent the supplement to you hot off the press. As was the case last year, the brochure contains information on new projects which are being financed wholly or in part by institutions which provide research funding.

We wish you pleasant reading and hope that you find the report informative.

The editorial team

INDUSTRY COOPERATION FOR POWER GENERATION USING SOFCS

Process simulation for system design evaluation

With currently three running SOFC[1] projects CUTEC is gaining more and more system competence that raises interest in the industry, e. g. companies supplying energy converters. In August 2011 the French company SOPRANO Industries and CUTEC started its cooperation for the development of an SOFC system.

SOPRANO Industries is the French market leader in the field of railways and specialist in the sectors of air conditioning and air diffusion, the conversion of energy and electronics in severe surroundings as well as on-board systems. Their flexible EnerTermoPac cogeneration module (figure 1) can provide hot and chilled water, heating and cooling as well as electricity from multiple sources like biogas, natural gas, diesel, electricity and hydrogen. The optimum energy source is selected based on the yearly or seasonal cost.

SOFC technology can extend the EnerTermoPac flexibility, increase the EnerTermoPac efficiency, compactness and reliability and reduce the maintenance costs. A small SOFC system could provide electricity and heat complementary to other sources within the EnerTermoPac cogeneration module driven by its central energy management. CUTEC is asked to provide multiple system design options that will fit into the EnerTermoPac concept to prepare a decision of a first SOFC system prototype development.

The SOFC technology is getting mature and with stacks from Topsoe Fuel Cell A/S the leading European stack supplier was chosen to deliver the core technology for such a system. Topsoe Fuel Cell, a 100 % subsidiary of Haldor Topsøe A/S in Denmark, has a manufacturing capacity of 5 MW per year for cells and stacks based on their high performance ASC[2] cell technology and stack manufacturing know how.

Fig. 2: Christian Moreau, Managing Director of SOPRANO and Prof. Carlowitz signing the cooperation at SOPRANO headquarter in Lyon, France

SOPRANO and CUTEC signed a first contract with for flowsheet simulation and performance maps for fuel cell generators of 2 and 10 kWe based on Topsoe Fuel Cells stack technology. The picture (figure 2) shows Christian Moreau, Managing Director of SOPRANO and Prof. Carlowitz, CEO of CUTEC after signature of the cooperation contract.

Topsoe Fuel Cell will now deliver stack and hotbox performance data as the core of the future system design. CUTEC will provide different options for system designs to deliver the required electrical power out of the specified fuel. Stationary system simulation will provide first fuel cell generator performance maps together with parameter evaluation showing the impact of certain design options regarding the final performance.

Soprano will than evaluate the advantages and drawbacks of multiple design options for the best fit into the EnerTermoPac environment. The process simulation work of CUTEC is seen as a feasibility study to develop an SOFC system prototype in a later stage. (di)

Fig. 1: SOPRANOs EnerTermoPac cogeneration module for multiple services

[1] Solid Oxide Fuel Cell
[2] Anode supported cell

BIOLOGICAL FUEL CELL

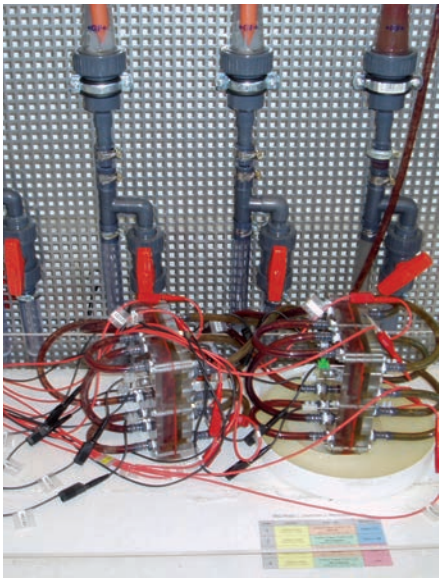
Initial results

MFC test bed

Microbial fuel cells (MFC) contain living microorganisms that produce electricity directly from complex organic substrates such as sewage. The power density is below that of chemical fuel cells by several decimal powers, but the mild reaction conditions (room temperature, ambient pressure) and more or less unlimited life of the self-regenerating biocatalyst are some real advantages of the new approach.

The results of a CUTEC feasibility study indicate that microbial fuel cells have considerable potential, particularly in sewage treatment applications. Tests confirm, for example, that pre-settled municipal wastewater can be treated below 60 mg/L COD. Wastewater treatment is particularly attractive due to the reduction of aeration energy additionally to the electricity generation. At currently achievable efficiency levels, a model 100,000 p.e. sewage treatment plant can produce 200 kW of electricity from 50% of biochemical oxygen demand. The process also reduces energy consumption needed for aeration by roughly 50 kW.

Further work will be needed in several areas, particularly with regard to low-cost materials and reliable reactor design before economic application may be possible.



MFC module media supply

MFC modules with four individual cells each

Tests with self-produced electrodes made of low-cost materials indicate that the road to applications may be shorter than originally thought. (si)

Continuation from page 4

BIOMASS AND RENEWABLE ENERGY IN THAILAND

presentation, he discussed the viability of using rice production residuals to generate energy in Asia. He compared the results of studies on the potential use of rice hulls and rice straw from Thailand, Vietnam, India and China. The discussions and opportunities for making new contacts continued during the conferences and subsequent visit to the show.

The week in Bangkok was highly informative. Mr. Siemers had an additional advantage which was very useful as he highlighted the expertise which CUTEC brings to the table on a whole range of energy-related technologies. The year before last, he returned after spending three years conducting research at JGSEE in Thailand, so he naturally has a wealth of local knowledge and good contacts in the country. During their presentations, speakers who had worked with Mr. Siemers at the time emphasised the value of his contribution. On a number of occasions, they mentioned that the results which they were presenting were partially based on work that Mr. Siemers had carried out while he was at JGSEE. (sie)

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SCIENTIFIC ADVISORY BOARD

A profile of Dr. Gohlke

Dr. rer. nat. Oliver Gohlke

In the last issue of CUTEC News, we reported that there have been a number of changes at the Scientific Advisory Board, and we briefly introduced the new members. In this issue of CUTEC News, we will tell you a bit more about one of the people who recently joined the Committee. The series of articles will continue in the future. We have started (arbitrarily) with Dr. Oliver Gohlke from the Munich-based firm MARTIN GmbH für Umwelt- und Energietechnik. CUTEC has a long-standing research partnership with MARTIN in the field of reverse-action grate technology. The company operates a pilot system at the Test Centre.

Oliver Gohlke, who is currently in charge of R&D at MARTIN, was born in Aachen in 1965. He was awarded the Diplôme d'Ingénieurs by the École d'Ingénieur ECPM in Strasbourg in 1989. With the aid of a grant from the Volkswagen Foundation, he completed his dissertation at the University of Applied Sciences in Munich between 1990 and 1993 working in collaboration with the Helmholtz Centre in Munich. The subject of the dissertation was thermal inertisation of waste incineration residue – heavy metal immobilisation and evaporation. The same year, Dr. Gohlke started his career in industry at MARTIN in Munich, and he has stayed with the company ever since. He was initially in charge of various waste-to-energy projects, and his area of responsibility included pilot plants inside and outside the country. He also provided assistance to the project departments during the market introduction phase before moving into his current role in 2003. His range of expertise includes energy efficiency, product and ash quality, combustion technology and new fuels. Dr. Gohlke is a member of various organisations such as the VDI Waste Management and Recycling Committee and WtERT (Waste to Energy Research und Technology Council). In 2008, he took over as chairman of the committee which has responsibility for the VDI Waste Management Assessment standard. When asked about his motivation for joining the CUTEC Scientific Advisory Board, Dr. Gohlke answered that he would like to use his experience in industry to help define a strategic roadmap which will ensure the success of the Institute's thermal process engineering, modelling, simulation and energy systems activities. Based on CUTEC's expertise and exceptional infrastructure, he sees excellent opportunities for collaborative development of new technologies which will enhance energy and resource efficiency in industrial applications. It is also his intention to promote the ongoing development of effective partnerships with industry and international networks. (he)

THE LATEST FROM THE CUTEC TEAM

Working life began "in earnest" for three young people at CUTEC in August 2011.

Mrs. Marylene Heidrich spent her first day with the CUTEC admin team on August 1st. Over the coming three years, she will receive in-depth vocational training in office administration.

Also on the first of August, Mrs. Anke Schärf started a one-year internship in the Admin Dept. as part of her vocational school training.

Starting on August 24th 2011, Mr. Kevin Müller will be learning the practical skills he needs for his course of studies at the technical college. During his one-year internship, he will be working in the mechanical workshop at CUTEC. (P.S.: Mr. Müller had not yet started as we went to press)

Marylene Heidrich (l.) and Anke Schärf

CONGRATULATIONS TO

Mrs. Jessica Micke and Mrs. Josefine Müller who passed their summer examinations and have now completed their vocational training in office administration. We wish to extend our thanks to them once again, and we wish them all the best for the future. (wes)

Jessica Micke (l.) and Josefine Müller